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ABSTRACT

Student's attitudes toward mathematics were studied in the literatute in relation to (1) IQ and achievement scores and (2) vocational choice and then measured using two new tests which were developed for this study. Positive and negative statements about mathematics were constructed, so that students could indicate degree of agreement or disagreement with them. A panel of six judges then rated each item for its suitability in the proposed attitude scale. The resulting items were administered to a group of students. They were separated into those who scored above, versus below, the median indicating a positive or a negative attitude. Those items which differentiated the two groups by a significant difference were kept. Item analysis was carried out on the mathematics items and on some items pertaining to attitudes toward French. When mathematics achievement was also considered as an external criterion, little relationship was found between attitude and achievement. A second measure was developed--a five-item check list of student behavior to be completed by the teacher. A panel of judges was again consulted. The 23-item attitude scale and the behavioral check list were administered to fifth, sixth, and ninth grade students. Teachers also provided mathematics achievement data. Although test reliability was .93, the correlation between attitude and achievement was low. The check list was a better predictor of mathematics achievement, especially in the ninth grade. A three-page bibliography concludes the document. (GDC)

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Human Assessment: Cognition and Motivation

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Abstract

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In education, the affective domaine is concerned with attitudes. Authors insist on the necessity of developing favorable attitudes toward subject matters. Can attitudes toward subject matters be related to IQ, to achievement, or to vocational choice? How can attitudes toward a subject matter be evaluated? This paper answers these questions.

First it explores through the literature and through experiments conducted by the author and his team, the relationship between attitudes an IQ and achievement scores. Also it explores the relationship between attitudes and vocational choice.

Correlation coefficients between attitudes scores and IQ or achievement are low. There is no relationship between attitudes and vocational choice.

This paper proposes two ways to evaluate attitudes toward a subject matter. The first deals with the validation of an attitude scale while the second, presents an informal attitude measure in the form of a check list.

Finally, the author presents the relationships between the attitude scores as experimented by these two techniques with the achievement scores.

ATTITUDES: THEIR RELATIONSHIP WITH INTELLIGENCE AND ACHIEVEMENT AND THEIR EVALUATION.

Jean Vachon

Introduction

Since KRATHWOHL et al (1964) has precised the taxonomy of educational objectives in the affective domain, this issue has preoccupied curriculum builders and test specialists. The affective domain refers to personality, values, attitudes and beliefs; this last one being the most superficial level and personality being the deepest level. The relationships are not only in depth, attitudes are also related to one another "across" at the same level(Oppenheim,1966). Religions, politics, moral, patriotism, good citizenship are heavily related to attitudes. They are founded on beliefs, attitudes and values that will direct human behavior in particular directions.

The attitudes and the cognitive domain

Our preoccupation today is different than these vast areas of human life. We are concerned with attitudes related to the educational objectives in the cognitive domain. In this sense then, attitude can be defined as a predisposition toward a situation, a person or an idea. This state of mind may be conscious or nonconscious, rational or irrational. The attitude may lead to a

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particular behavior but not necessarily.

Because attitudes, like intelligence, are not physical things but constructs, they are hard to define. We know that they exist but we cannot see them; we can only observe their effects. We know a lot more about intelligence than about attitudes. But we know a lot more about subject matters like reading, mathematics and sciences than we know about constructs like intelligence and attitudes. We do a lot more in the development and evaluation of subject matters than in the development and evaluation of these constructs. For example, we know how to teach mathematics as a subject but we don't know how to develop attitudes toward mathematics because these attitudes are constructs.

If ones looks in a curriculum guide for the elementary school, a general cognitive objective is "the child must learn to read", this objective has been broken down into hundreds of specific objectives expressed in behavorial terms. But a close look in the affective domain will reveal only general objectives like "the child will appreciate reading". In this domain almost nothing has been done concerning the way to develop attitudes nor to evaluate the achievement of the child.

Maker (1982) wrote that "it is impossible to separate the cognitive from the affective domains in any activity.

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The most important is that there is a cognitive component to every affective objective and an affective component to every cognitive objective" (p.30). Payne (1974) had expressed the same idea: "Cognitive and affective outcomes interact to the degree that they are virtually inseparable. Affective outcomes directly influence learning and also constitute legitimate educational outcomes in themselves" (p.30). It would be misreading these statements if one interprets them as meaning that developing cognitive objectives will lead automatically to the development of the related affective objectives. In other words it cannot be concluded that since a child will know how to read he will enjoy reading.

Our own research as well as many others, shows that there is defenitely no relationship between the results of the cognitive measures and the results of the assessment of attitudes. The highest coefficient obtained between attitudes and mathematics was .51, the lowest, -.09 with a median of .25; between attitudes and science, the highest was .33 the lowest, -.17 with a median of .19; between attitudes and reading, the highest was .51, the lowest, .04 with a median of .16. Between attitudes and social studies two r were computed, one was .13 the other was -.12. Another study established a correlation

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coefficient of .11 between attitude and language and another research found an r of .29 between attitudes and IQ.

As Keith (1972) wrote "while r is difficult to interpret with any exactitude, the square of r has a different quality. It means the proportion of variance in the X variable which can be explained by variance in Y, or vice versa".(p.46). This means that the greatest common variance observed between an attitude test and an achievement is 0.25 and the lowest is zero.

If attitudes and achievement are related it means that from the score on one test we can predict the score on the second test. Ephrem (1969) gave a formula to evaluate the predictive value of a coefficient of correlation for an individual student.
This formula is $(1-(1-r^2)^{1/2})100$. From this formula it means that with a correlation coefficient of .51 we can ameliorate the prediction by 14% on the simple hazzard and with correlation of .25 by 3.2% on the mere chance.

So from these data, it would be hard to attest that there is a relationship between attitudes and achievement or IQ results, and difficult to maintain the belief that "prime among the variables which determine achievement is attitudes" (Steinkamp, 1982): Likewise,it is difficult to believe that the mere fact of teaching for the attainment

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of cognitive outcomes will develop the affective objectives.

However, it seems that the affective domain is not linked with the cognitive domain. Its developmental path does not follow the development of the cognitive domain. Both are to be developed in the same individual but in different ways with different methods and evaluated with different tests.

The attitudes and the vocational choice

It was also hypothesized that attitudes might be related to vocational choice. Astin and Nichols (1964) defined vocational choice in these words: "In fact it is possible to think of vocational choice as a person's attempt to find that work situation which will maximize his chances of achieving the goals which are important to him". The studies that have been run in this field used the Crites' Career Inventory. One subtest of the instrument is the Career Choice Attitudes, a true-false, fifty item scale. Westbrook et al (1980) compared this attitude scale with some other cognitive tests and found correlation coefficients of .56 with the Otis Lennon Mental ability Test, of .54 with the Metropolitan Reading test, of .49 with the Metropolitan Language Test, of .60 with the Scholastic Aptitude Test Verbal and of .56 with the

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Scholastic Aptitude Test Mathematical. Neely and Hanna (1977) found a correlation coefficient of .34 between the Crites' attitude scale and the Occupational Aspiration Scale. If these correlation coefficients are evaluated with the criteria that were used to appreciate the relationship between attitude and subject matter, it mean that the largest common variance between the Crites' Attitude Scale and an other test is .36 and that an r of .60 will improve the prediction for an individual student by 20% on the mere chance. Are these figures high enough to lead to the conclusion that the Crites' Attitude Test is a good predictor for the other personality measure?

For her part, Steinkamp (1982) studied in a meta analysis the data presented in many studies about the difference in attitude between the sexes in relation to science studies. She arrived at the conclusion that "in most studies there are no difference between boys' and girls' attitudes toward science and when there are, the girls' less positive attitudes toward science are too slight to provide grounds for limiting the life options of females. Clearly mean differences in attitude toward science cannot be used as an explanation for females' underrepresentation in science professions." From this citation it may be concluded that there are no relationship between attitudes toward science and the

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vocational choice. If there is no relationship between attitude toward science and the vocational choice there is no ground for the hypotheses that there would be a relationship between attitudes toward any subject matter and the vocational choice.

The evaluation of attitude

Even if attitudes have no relationship with the cognitive domain, they have to be developed, and for that we need ways and means to evaluate if the teaching objectives have been reached.

The valadation of atttitude scales

One way to evaluate attitude is with an attitude scale (Tuckman, 1975). The second purpose of this paper is to present a new reliable procedure by which to build and to validate an attitude scale.

The proposed procedure is a mixture of the Thrustone Technique (Thurstone, 1929) and of the Likert Method (Likert, 1932). The panel of judges comes from Thurstone. The collection of statements - favorable or unfavorable - about a particular subject, and the scale, which allows the student to express his attitudes, come from Likert. The role of the judges is simplified and the statistical analysis is new.

If one wants to make an attitude scale one must first

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define attitude in an operational form that stipulates the operation by which attitudes could be observed and measured. Attitude towards mathematics would be defined as a feeling which can be measured by asking the student to approve or to disapprove of statements (positive or negative) about mathematics.

If the intent is to measure attitudes toward mathematics, the statements must be about mathematics only and not about something related to mathematics, such as the math teacher since the scale is a measure of the attitudes towards mathematics and not towards the teacher. One student may love his arithmetic teacher but hate the subject matter. If he agrees with the following statement: "I am happy when the arithmetic teacher comes into the classroom" it would not inevitably mean that he has a positive attitude toward mathematics.

After the attitude is defined, one must build statements (positive and negative) about it. How many? It is hard to say. The author of this paper thinks that about twenty to thirty would be enough because, usually after the item analysis, half of them would be discarded.

To ensure the validity of the scale it should be submitted to a panel of six judges. These judges are usually faculty members specialized in different areas. Because it is a scale, some of the judges may be

specialized in the test and measurement area; because the objective is to measure attitudes, some judges may be specialized in psychology and because the attitude measured is about mathematics, other judges may be math specialists. It is very important that the panel be comprised of people of different interests and specializations not necessarily related to the objective of the test because each judge must accept or reject the statements according to his own point of view, so that many points of view would be represented. The reason for this is that the students will not necessarily form an homogeneous sample. One precaution to ensure the proper selection of the panel is that all judges must be favorable to the measurement of attitudes. If any are convinced that attitudes cannot be evaluated, s/he won't accept the measuring instrument.

When the panel is selected, each judge would receive the proposed scale and would be asked three questions:

1. Is the scale as a whole a good tool to measure attitudes toward mathematics? (If the scale is made to measure this attitude).
2. Does every particular statement express an attitude toward mathematics?
3. If so, is the expressed attitude a positive or a

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negative one?

The criterion recommended is five out of six. This means that on the first question at least 5 judges must agree that the scale is a device to evaluate attitudes toward mathematics. If this criterion is not reached, we must go back to the drawing board.

On the second question, at least five judges must agree that each statement expresses an attitude. If two or more judges do not agree, that statement is discarded.

Once again,for the third question, at least five judges must agree that each response given is clearly either negative or positive.

The criterion '5 out of 6' may seem harsh but if the judges interpret a statement in different ways, then the student probably will as well and perhaps more so since they may not be as sophisticated in the measurement of attitudes as the judges. After the scale undergoes an evaluation by the judges it is time to try it with real pupils for an item analysis.

For this item analysis, internal criterion is used.The scale is administered to a group of students and then scored. If the scale is a five-step scale going from 'strongly agree' to 'strongly disagree' the positive statements will be scored from 5 to 1 for 'strongly agree'

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to 'strongly disagree'. The statements judged by the panel members as negative will be scored from 1 to 5 for 'strongly agree' to 'strongly disagree'.

The students will be scored on the total scale and classified from the lowest score to the highest score and then separated into two groups - the group which scores higher than the median and the group which scores lower than the median. The means of both groups on each statement would be compared with a "Student t" test. Only the statements that differentiate the two groups by a significative difference (at least at the level of .10 or preferably at the level of .05) on their averages would be kept. All the others would be discarded.

This analysis allows also to check the opinion of the judges on the positiveness or the negativeness of each response. According to the opinion of the panel all the averages of the higher group must be significantly higher than the average of the lower group. If the lower group scores higher than the higher group on a particular statement, then this statement must be recoded in the reverse sense. This procedure was experimented on two attitude scales in two different subject areas, French and Mathematics. The same procedure for the item analysis was also tried but using an external criterion: student competency in the subject matter. With the attitude scale

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toward French, when the internal criterion was used, only one item out of twenty-four was rejected but when the external criterion was used, twenty-three items out of twenty-four were discarded. With the attitude scale toward mathematics, when the internal criterion was used, only two out of twenty-one items were rejected at the .10 level of significance. When the external criterion, the achievement-in-mathematics test was used, fourteen out of twenty-one statements were discarded.

In view of this fact, a review of the literature was done and it appeared that the relationship between achievement in mathematics and attitudes toward mathematics is relatively quite low. The highest coefficient found in different studies was .40 and the lowest was .15. From this fact Neale (1969) wrote that the attitudes toward mathematics explains only from 5 to 15% of the variance of the scores of the achievement tests in this subject.

Because of the low relationship between attitudes and achievement and because of the data gathered in the try-out of the item analysis with an external criterion, the author of this paper believes that an internal criterion must be preferred to an external criterion. In other subjects, before using an external criterion to separate

groups, at the median for the items analysis, the researcher would be better off to verify and see if the relationship between the attitudes and the external criterion is high enough (Shaw and Wright,1967). To test the reliability of the scale, it is proposed to use the split-half technique. This technique is a measure of the internal consistency of the attitude test. After that the item analysis is done and the incorrect items have been discarded a correlation coefficient is completed between scores on the odd-numbered and even numbered items. The Spearman-Brown formula is applied on the correlation coefficient. The Kuder-Richardson technique or the alpha coefficient would be as good to test the reliability of the scale.

How high must a reliability coefficient be? In 1966, Oppenheim (p.122) suggested that a reliability coefficient of .80 would be good. But from the published attitude scales reviewed for this paper, the author think that a good reliability coefficient must be around .90 or higher and that a coefficient of .85 is acceptable.

The validation of an attitude checklist

Another way of assessing attitudes toward a subject matter is through a check list filled out by the teacher (Vachon, 1982, p.208-210). To build such a check list, one must find some behaviors expressed by the child that

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reveals his attitudes (positive or negative) toward a subject matter. For example behaviors like smiling, singing or hurrying on the job, would indicate a positive attitude whereas behaviors like daydreaming, playing on the job or expressing complaints about the subject might express negative attitudes. There is no need to have a lot of them in the check list but only behaviors that will firmly express positive or negative attitudes may be present because the observer, usually the teacher, will be asked to check if the children expressed the behavior or not. The most important feature of such a grill is that the behaviors to be observed must be visible to the observer and must explicitly express the positive or negative attitude How many behaviors are needed. Not too many because, the observer, usually the teacher, will have to evaluate every one of his pupils on every behavior (if the behavior is usually exhibited or not): If there are too many behavior items, it will be burdensome on the teacher but, if there are not enough of them, the check list will not differentiate among students. It would be good to have a maximum of ten behaviors and a minimum of 5.

To validate such a check list, the author submitted it to a panel of six judges. The members of the panel were

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chosen in the same way that was described earlier. They had to answer the same questions as for the attitude scales except that the word statement is replaced by the word behavior. The criterions are also the same.

How to grade such a check list? Let's suppose that the check list is made of 5 behaviors expressing positive attitudes and of 5 behaviors expressing negative attitudes. First let's count the total of behaviors expressing positive attitudes checked by the observer for each of the students. This total will vary from 0 to 5. After this is done, lets do the same thing with the behaviors expressing negative attitudes. Once again the total will vary from 0 to 5. The next step consists in adding the total obtained for the behaviors expressing positive attitudes to the number 5. If the teacher has checked 5 behaviors expressing positive attitudes to a student, this student's total will be ten. If the observer has not checked any behaviors expressing positive attitudes to a student, this student's total will remain 5. After, this is done for every students on the list; The next step consists in subtracting the total obtained for the behaviors expressing negative attitudes from the total expressing positive attitudes. If the observer had checked only behaviors expressing negative attitudes for a student, let's suppose 5, the last total will be 0. Let's

suppose that a student was checked 2 positive behaviors and 3 negative ones, his first total will be 5 + 2 = 7 and his final mark will be 7 - 3 = 4. In this way, the final score may vary from 0 to ten inclusively. What kind of scores are these? They are positional scores as are centile ranks. How to interpret them? These scores have not the exactness of a yardstick. The student who has a score of 8 was judged by his teacher to have expressed more behaviors expressing positive attitudes than did the student who received a score of 7 or less, and less than the student who received a score of 9 or ten. The scale just described is an eleven step scale with a neutral point, 5 (the median) and a maximum of ten at the more positive end and a minimum of 0 at the more negative end.

The expiremental of the techniques

A scale and a check list to evaluate attitudes toward mathematics has been validated using the techniques described earlier and experimented on two grade five groups, on two grade six groups, and on two grade nine groups. The attitude scale was composed of twenty-three statements favorable or unfavorable to mathematics. The students had to choose between three choices: " I think it is true", " I think it is not true" or " I don't know". The check list included 5 behaviors expressing positive

attitudes and 5 behaviors expressing negative attitudes.

The 6 teachers were asked to look closely at the check list and to observe their students for a number of days and then to fill out the check list when they would feel comfortable to do so. Once this task was completed, the children filled out the attitude scale. The teachers were also asked to give the mathematic results for each student.

For the sixth grade, the split-half reliability coefficient,corrected with the Spearman-Brown formula was .93 for our ninety-five students and for the ninth grade it was also .93 for 54 students. We have also computed correlation coefficients between the attitude measures and the class mathematic results. For the sixth grade the coefficients were: between the attitude scale and the check list, $\underline{r}$ .26; between the attitude scale and the mathematics score, $\underline{r}$.04 and between the check list scores and the mathematics test, $\underline{r}$ .37, and for the ninth grade we had two mathematics tests. One was administered in September and the other in November. The correlation coefficients were: between the attitude scale and respectively the two mathematics tests scores, .25 and .21, and between the check list scores and the two mathematics tests scores, respectively .62 and .66. Between the attitude scale and the checklist the $\underline{r}$ was

.09.

Reliability coefficients of .93 are high. It means that the attitute scale has a high degree of intern consistency and that the procedure used to validate it was a good one. As it was stated earlier in this paper, the observed coefficients between attitude scores and achievement scores are usually low. It is what happened in this experiment, the obtained coefficients of .04 in grade six and of .25 and of.21 in grade nine express very low relationships between attitudes and mathematics and confirm the validity of the procedure used. In grade six, the near zero correlation coefficient would indicate that, at this level, there is no relationship between attitudes and mathematics. Further studies will have to be conducted to verify this point. The higher relationship observed between the attitude checklist and the mathematics scores may be explained in this way. The teachers who observed the students to fill out the checklist knows them through their achievement in mathematics and this knowledge may have influenced their judgment in checking the presence or the absence of the behaviors expressing attitudes. It might be for this reason that the ninth grade coefficients (.62 and .66) are higher than the sixth grade coefficients (.37), the ninth grade teachers teach only one or two

subject matters to their students and their knowledge of the students is affected only by the achievement in this subjects whereas the sixth grade teachers teach every subject matters to their pupils and their knowledge of their students is affected by all these subjects as a whole. This hypothesis has to be verified.

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